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LIQUID FLOW MONITORING APPARATUS

Field of the Invention

The present invention generally relates to liquid flow monitoring and, more specifically to liquid flow control and measurement apparatus.

Background of the Invention

It is known in the art to provide intravenous delivery of liquids and medicaments to a subject. Intravenous therapy is generally carried out by feeding medicament together with or in the absence of saline solution from a bag or other supply source. The rate of delivery is generally controlled using a valve associated with a flow-monitoring device. The flow rate is commonly monitored in accordance with an observed droplet rate passing through a droplet-monitoring device.

Known droplet-monitoring devices have several drawbacks, including the following: the liquid flow rate is not readily observable at a glance; counting the droplet rate is both time consuming and not easily discernible; the device is required to be in a substantially stationary, vertical position, having the supply bags of medicament and saline suspended thereabove; and controlling an intravenous flow to a subject under emergency conditions outside of a hospital environment may prove problematic if not impossible using a droplet counter device.

An understanding of the state of the art in fluid flow control and metering may be obtained with reference to the following exemplary United States patents:

US Patent number 4,136,692 to Goldowsky discloses a "Flow meter administration device" including a metering

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device to enhance a drip chamber, but it is complicated and the flow rate is not readily discernible.

US Patent numbers 5,005,604 to Aslanian for a "Flow control device for administration of intravenous fluids and 5,267,957 to Kriesel, et al. for a "Closed drug delivery system" disclose flow control systems without unique metering capability. The same is true of US Patent number 5,499,968 to Milijasevic for "Flow controllers for fluid infusion sets."

US Patent numbers 5,840,071 and the Continuation-in-part thereto, 6,176,845 to Kriesel, et al. disclose "Fluid delivery apparatus with flow indicator and vial fill" that includes "a highly novel fluid flow indicator that provides a readily discernible visible indication of fluid flow" but which is complicated to implement.

US Patent number 6,679,865 to Shekalim discloses a "Fluid flow meter for gravity fed intravenous fluid delivery systems" that combines a complicated mechanical and sensor system with a drip chamber.

All of the above examples of prior art are meant for medical applications such as intravenous therapy. US Patent numbers 5,402,686 to Wittmann for a "Float type flowmeter" and 6,003,549 to Delacroix, et al. for a "Flow measuring device" both are meant for industrial applications. They both employ conically-shaped flow chambers with indicator elements whose position in the chamber is indicative of the fluid flow rate. However, they both work with upward, rather than gravity fed flows such as are used in medical applications such as intravenous therapy. Further, they are both meant for higher flow rates than are commonly required in medical applications.

Summary of the Invention

The present invention aims to provide an accurate and consistent liquid flow monitoring apparatus for intravenous therapy under circumstances and in environments that include hospitals, places of alternate healthcare, emergency events in the field and in circumstances where stability and consistency are generally problematic or nonexistent. Furthermore, the present invention seeks to provide monitoring of intravenous therapy with minimal participation by healthcare professionals, providing a readily observed indication of the flow status.

According to a preferred embodiment of the present invention, there is provided apparatus for monitoring liquid flow, which may preferably be included in an intravenous therapy apparatus including one or more sources of intravenous liquid, a supply tube apparatus arranged in liquid flow communication with each source of intravenous liquid including a flow regulating valve and an intravenous insertion member associated in flow communication with the supply tube apparatus, including a generally elongate housing having first and second ends having formed therein a liquid inlet and outlet, respectively, for permitting a liquid flow through the housing. The housing has a cross-sectional profile, which varies along its length so as to impart predetermined flow characteristics (e.g., flow resistance which varies according to the geometric design of the housing) to a liquid flowing therethrough. The apparatus further includes a flow rate indicator float disposed within the housing operative to be displaced therealong in accordance with a liquid flow rate therethrough and flow rate indicator means associated with the float member, for

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providing a position-related indication of the rate of liquid flow through the housing.

According to a first embodiment of the present invention, the apparatus for monitoring liquid flow includes a portion of the elongate housing formed having a conical-shaped internal surface.

According to a second embodiment of the present invention, the generally elongate housing is formed having a first housing portion having a conical-shaped internal surface and a second housing portion having a cylindrical internal surface thereby providing for an increased liquid flow therethrough.

According to a third embodiment of the present invention, the elongate housing includes a side-wall having a generally cylindrical configuration and a longitudinal axis and having one or more diametric slots formed within and along the longitudinal axis, wherein the slot has a predetermined lateral width and has a diametric width which varies along the longitudinal axis, thereby imparting to the housing a varying cross-sectional area accordingly.

According to a fourth embodiment of the present invention, the housing includes a plurality of internally stepped housing portions thereby imparting to the housing a varying cross-sectional area accordingly.

According to a fifth embodiment of the present invention, one or both of the first and second ends of the housing has internal recesses formed therein concentric with the inlet and outlet so as to provide a valve seat for operationally engaging the flow rate indicator float thereby closing off liquid flow through the elongate housing.

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According to a sixth embodiment of the present invention, the flow rate indicator float is generally cylindrical having integral first and second end walls.

According to a variation of the sixth embodiment of the present invention, one or both of the first and second end walls is formed having a conical protrusion formed concentrically therewith for operationally engaging the internal recesses formed in the first and second ends of the housing thereby closing off liquid flow through the housing.

According to a seventh embodiment of the present invention, the flow rate indicator float is formed having a plurality of projections protruding generally radially therefrom thereby to reducing contact of the float with the housing.

According to an eighth embodiment of the present invention, the flow rate indicator float is spherical.

According to a ninth embodiment of the present invention, the elongate housing includes a housing bypass channel in operative association with a valve member for providing a liquid flow to bypass the flow rate indicator float.

According to a tenth embodiment of the present invention, the flow rate indicator float is formed having a hollow therein so as to entrap gas therein, thereby increasing the buoyancy thereof.

According to an eleventh embodiment of the present invention, the flow rate indicator float includes apparatus for providing remote signals indicative of the displacement of the flow rate indicator float in relation to the flow rate indicator means and thereby of the liquid flow through the elongate housing. The apparatus for providing these remote signals may further provide visual

and/or audible alerts whenever the flow rate indicated by said flow rate indicator is not within a predefined flow rate range.

The monitoring apparatus may further comprise a filter chamber at the lower end of the elongate housing and in liquid communication with the liquid outlet, wherein the chamber comprises a filter disposed therein such that fluids passing through the chamber are filtered by the filter, and wherein entrance of air bubbles from the filter into the elongate housing is blocked in the chamber. Optionally, the filter chamber can be partitioned into sections that are used for trapping the air bubbles. Alternatively, the filter chamber may be located at the upper end of the elongate housing and in liquid communication with the liquid inlet, wherein said chamber comprises a filter disposed therein such that fluids passing therethrough are filtered via said filter. Alternatively, the filter may be provided at other locations along the fluid flow path not included in the flow monitoring apparatus.

Furthermore, there is provided a method for monitoring a liquid flow rate through an intravenous therapy apparatus, including the steps of:

- a) providing a liquid flow monitoring apparatus, including flow rate indicator means having a flow rate indicator float, in liquid flow association with an intravenous therapy apparatus;
- b) purging air from the liquid flow monitoring apparatus by causing liquid to flow from a liquid supply member into a liquid inlet of the intravenous therapy apparatus and therethrough;
- c) preselecting a rate of flow of liquid through the intravenous therapy apparatus;

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- d) providing a visual indication of the rate of liquid flow through the liquid flow monitoring apparatus as indicated on the flow rate indicator means, by linear displacement of the flow rate indicator float;
- e) selectively adjusting the rate of liquid flow through the intravenous therapy apparatus;
- f) visually inspecting the position of the flow rate indicator float against the flow rate indicator means; and
- g) associating the position of the flow rate indicator float in the flow rate indicator means with the rate of liquid flow through the intravenous therapy apparatus.

The method further includes, following step b), the step of repeating the purging of air from the flow monitoring apparatus.

Brief Description of the Drawings

The present invention will be more fully understood and its features and advantages will become apparent to those skilled in the art by reference to the ensuing description, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic view of a liquid flow rate monitoring apparatus, constructed and operative in accordance with an embodiment of the present invention, with no liquid flowing therethrough;

Figure 2 is a schematic view of a liquid flow rate monitoring apparatus with liquid flowing at a preselected rate therethrough;

Figure 3 is a schematic view of a liquid flow rate monitoring apparatus with a high rate of flow therethrough;

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Figure 4 is a schematic view of a liquid flow rate monitoring apparatus with an excessive liquid flow therethrough;

Figure 5 is a schematic view of a liquid flow rate monitoring apparatus illustrating a cessation of liquid flow;

Figure 6 is a schematic view of a liquid flow rate monitoring apparatus including a float with an occluded bubble of gas;

Figure 7 is a schematic view of a liquid flow rate monitoring apparatus including a float with an occluded bubble of gas sealed therein;

Figure 8 is a schematic view of a liquid flow rate monitoring apparatus including a float with an added float element;

Figure 9 is a schematic view of a liquid flow rate monitoring apparatus having a diametric housing slot;

Figure 10 is a cross-sectional view of an upper housing portion of apparatus shown in Figure 9;

Figure 11 is a cross-sectional view of a lower housing portion of apparatus shown in Figure 9;

Figure 12 is a schematic view of a liquid flow rate monitoring apparatus having a housing formed of a plurality of stepped cylindrical housing portions;

Figure 13 is a schematic view of a liquid flow rate monitoring apparatus having a liquid by-pass;

Figure 14 is a schematic view of a liquid flow rate monitoring apparatus having an open liquid by-pass valve;

Figures 15 and 16 are schematic views of liquid flow rate monitoring apparatus having floats with radial protrusions;

Figure 17 is a schematic view of a liquid flow rate monitoring apparatus having a spherical float;

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Figure 18 is a schematic view of an intravenous apparatus including a liquid flow rate monitoring apparatus, constructed and operative in accordance with an embodiment of the present invention;

Figs. 19A, 19B, and 19C are cross-sectional views of the liquid flow rate monitoring apparatus of the invention having a filter chamber near the apparatus outlet;

Fig. 19D is a top view of a filter; and

Fig. 20 is a cross-sectional view of the liquid flow rate monitoring apparatus of the invention having a filter chamber near the apparatus inlet.

Detailed Description of the Invention

Whilst the details that follow hereinbelow generally relate to monitoring the flow rate of liquids in intravenous therapy, it will be apparent to persons skilled in the art, that embodiments of the present invention are applicable to many fields and applications. Such applications include those requiring sensitive and accurate liquid flow monitoring, especially at low flow rates. Applications include laboratory work, chemical processing and manufacturing, and biochemical manufacturing, to mention a few. Liquids to be monitored include liquids and corrosive or toxic liquids.

There is a need in the art for apparatus, which accurately monitors intravenous therapy. This is particularly applicable with patients in an emergency situation, including outside of a hospital environment. Further, it is advantageous to monitor intravenous therapy with a minimal of professional participation or supervision. The presently generally utilized droplet monitoring flow device cannot effectively function without the presence of air in the tubing, which, as is known to

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those familiar with the art, can prove problematic in treatment under non-ideal, but realistic, circumstances.

According to embodiments of the present invention, as shown and described below in conjunction with Figures 1-18, the flow monitoring apparatus of the present invention is compact, and inexpensive. Furthermore, visual indication of the flow rate is readily discernible and the apparatus operates without the necessity of air in the system. In addition, the flow monitoring apparatus can be used with minimal professional assistance, which is particularly beneficial in an alternate health care environment, such as the home or under virtually any emergency situation.

With reference to Figures 1 to 3 there is seen, according to a preferred embodiment of the present invention, a liquid flow rate monitoring apparatus generally referenced 10. Monitoring apparatus 10 includes a housing generally referenced 12 having an at least partially optically transparent generally cylindrical side-wall referenced 14 integrally formed with and disposed between first, upper and second, lower housing ends referenced 16 and 18, respectively. A liquid inlet referenced 20, and a liquid outlet referenced 22, are formed respectively in first and second housing ends 16 and 18 having formed within ends 16 and 18, conical-shaped recesses referenced 24 and 26, respectively.

Side-wall 14 is formed having in an upper internal portion generally referenced 28 thereof an internal conical shaped portion referenced 30 and having in a lower internal portion generally referenced 32 an internal cylindrical shaped portion referenced 34. Internal diameter of cylindrical shaped portion 34 is formed larger than the maximum diameter of conical shaped portion 30.

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Disposed within housing 12 is a float referenced 40, formed having a generally cylindrical shape and with transverse generally planar upper and lower end faces referenced 42 and 44 respectively. Formed on upper and lower end faces 42 and 44 are generally conical protrusions 46 and 48 respectively which are so shaped so as to provide a liquid seal when coming into operative engagement with conical shaped recesses 24 and 26, respectively. Float 40 is formed so as to have buoyancy relative to liquids to be applied to monitoring apparatus 10. The buoyancy of float 40 relative to the liquid to be monitored is preselected to provide a predetermined flow range for the liquid as disclosed hereinbelow.

When liquid enters through inlet 20 of flow monitoring apparatus 10 from a regulated liquid supply (not shown), a liquid flow force is applied against the buoyancy of float 40, to cause float 40 to be displaced downward within housing 12. As float 40 is caused to be displaced downwards within housing 12, annular gap referenced 50 between float 40 and conical shaped portion 30 of side-wall 14 progressively widens thereby providing for a progressively greater flow of liquid therethrough. When the downward pressure exerted on float 40 by the flowing liquid is counterbalanced by the upward thrust caused by the buoyancy of float 40, float 40 arrives at an equilibrium, stationary position within housing 12 as seen in Figure 2. Float 40 functions also as a flow rate indicator, substantially in proportion to the rate of liquid flow through monitoring apparatus 10, the liquid flow eventually exiting through outlet 22. The actual flow rate may be observed with reference to the position of float 40, relative to a calibrated scale (not shown), disposed axially along side-wall 14 in visual proximity

thereto. Optionally, the monitoring apparatus 10 may comprise various calibrated scales for providing flow rate readings of liquids having different viscosities.

In accordance with an additional embodiment of the present invention, there is disposed within float 40 an apparatus (not shown) for providing a remote signal indicative of the displacement of float 40 along the longitudinal axis of housing 12. Alternatively or additionally, displacement of float 40 may be measured by externally attaching to housing 12 a sensing device (not shown) capable of sensing displacements of float 40 and generating a corresponding signal. The displacement of the float 40 may be obtained by utilizing suitable means and methods known in the art, such as optical means (e.g., InfraRed emitter(s) sensor(s)), inductance means (e.g., magnetic inductance sensor(s)), resistive means or the like. For example, a light reflecting (e.g., mirrored) surface may be provided on the float 40 such that a light beam impinging on said surface is reflected back to its origin, sensed by a sensing device, and processed to determine the float displacement.

The displacement indication signal may be transmitted via conducting wires (or wirelessly) to a monitoring device (not shown) for displaying the flow rate and for processing and producing alerts (e.g., vocal and/or visible alerts indicating too low and/or too high flow rates), if necessary. Alternatively, the monitoring device may be coupled to the monitoring apparatus 10. The monitoring device may be a programmable device and in this case it may be adapted to provide alerts indicating deviations of the flow rate from a predefined range of flow rates (e.g., $\pm 5\%$ deviation from a predetermined flow rate set-point).

In accordance with another embodiment of the present invention, referring now to Figure 4, in response to an increase in flow, float 30 is caused to be displaced downwards within housing 12 into internal cylindrical portion 34 as seen in Figure 3. With a further, excessive, increase in flow, float 30 is displaced downward so that lower face 44 and lower conical protrusion 48 are caused to engage lower end wall 18 and conical recess 26 respectively, thereby causing a cessation of the excessive flow.

Furthermore, referring to Figure 5, in response to a cessation of the intravenous liquid flow, float 30 rises within housing 12 so that upper face 42 and upper conical protrusion 46 are caused to engage upper end wall 16 and conical recess 24 therein, respectively, effectively closing off any reverse flow, such as any blood out-flow from an intravenously placed cannula (not shown).

In accordance with embodiments of the present invention, the range over which the rate of flow is to be monitored is determined by selecting a float having a buoyancy preselected for the range of flow required.

Monitoring apparatus 10 can be used for continuous infusion of antibiotics, hormones, steroids, blood-clotting agents, analgesics, saline solution and other medicinal agents. Similarly, monitoring apparatus 10 can be used for intravenous chemotherapy. Accurate delivery of liquids, at flow rates as low as 40 ml/hour or less, at precise discernable rates and over extended periods of time, with minimal professional participation is feasible in accordance with embodiments of the present invention.

In accordance with embodiments of the present invention, the range over which the rate of flow is to be

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monitored is determined by preselecting alternative float configurations as are disclosed hereinbelow.

Referring now to Figure 6, in accordance with a further embodiment of the present invention, there is seen a liquid flow rate monitoring apparatus generally referenced 100, having a housing referenced 102 substantially similar to that disclosed hereinabove in relation to Figures 1 to 4. An alternative float 104 is operative in housing 102. Float 104 has a hollow referenced 106, formed in an under-side generally referenced 108, thereby providing increased buoyancy to float 104 such that a higher flow of liquid may be utilized through housing 100. Hollow 106 may comprise a bubble of gas (e.g., air) occluded therein.

Referring now to Figure 7, in accordance with one other embodiment of the present invention, there is seen a liquid flow rate monitoring apparatus generally referenced 120, having a housing referenced 122 substantially similar to that disclosed hereinabove in relation to Figures 1 to 4. A hollow float 124 is operative in housing 122. Float 124 has a hollow referenced 126, formed in an under-side generally referenced 128 thereof. A closure element referenced 130 is fixably transversely disposed into underside 128 so as to seal hollow 126. The entrapped gas in hollow 126 provides increased buoyancy to float 124 such that a higher flow of liquid may be utilized through housing 120.

Referring now to Figure 8, in accordance with an added embodiment of the present invention, there is seen a liquid flow rate monitoring apparatus generally referenced 140, having a housing referenced 142 substantially similar to that disclosed hereinabove in relation to Figures 1 to 4. A float 144 is operative in housing 142. Float 144 has

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a supplementary float portion 146, fixably disposed in an under-side portion generally referenced 148, such that supplementary float portion 146 provides increased buoyancy of float 144 allowing a higher flow of liquid may be utilized through housing 140.

Referring now to Figures 9, 10 and 11, in accordance with another embodiment of the present invention, there are seen schematic views of a liquid flow rate monitoring apparatus generally referenced 160, having a variable depth diametric housing slot referenced 162. As disclosed hereinabove in relation to Figures 1-3, housing 12 is formed with a linearly variable cross-sectional area, specifically a conical shaped internal side-wall 14. In Figure 9 housing 164 is formed with a cylindrical side-wall 166 having one or more internal diametric slots 162, axially disposed in side-wall referenced 166 having a preselected width. As seen in Figure 10, which is a cross-sectional view taken at 1-1 in Figure 9, the diametric depth of slot 162, measured close to the inlet end portion referenced generally 170 is substantially small and increases along the length of side-wall 164 to reach a maximum preselected depth adjacent to the outlet end portion referenced 172 as illustrated in Figure 11 which is a cross-sectional view taken at 2-2 in Figure 9. This variable depth of slot 162 provides a variable cross-sectional flow area to provide a displacement of float referenced 174 in accordance with the rate of flow of liquid through housing 164. It will be appreciated by persons skilled in the art that additional slots similar to slot 162 formed in the interior of housing 164 will provide added variation to the cross-sectional flow area of housing 164.

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Referring now to Figure 12, in accordance with one other embodiment of the present invention, there is seen a schematic view of a liquid flow rate monitoring apparatus generally referenced 175 having a side-wall referenced 177 formed as a plurality of stepped cylindrical housing portions referenced 179 having varied internal diameters arranged sequentially. The arrangement of the plurality of housing portions 179, provides side-wall 177 effectively with a conical shape which provides a variable cross-sectional flow area so as to provide a displacement of float 181 in accordance with the rate of flow of liquid through housing referenced 183.

Referring now to Figures 13 and 14, in accordance with a further embodiment of the present invention, there are seen schematic views of a liquid flow rate monitoring apparatus generally referenced 180 having a liquid by-pass referenced generally 182 formed in side-wall 184 of housing 186. Liquid by-pass 182 includes an axial channel 188 and a stop-cock referenced 190 which is maintained in a closed position as seen in Figure 13 during regular use. After the flow of liquid is terminated, so as to provide a quick-acting zero flow indication, stop-cock 190 is opened as seen in Figure 14 so as to cause float referenced 192 to rise rapidly to the inlet end generally referenced 194 of housing 186.

In accordance with an additional embodiment of the present invention, referring now to Figures 15 and 16, there are seen examples of schematic views of liquid flow rate monitoring apparatus generally referenced 200 and 220 respectively. In Figure 15, so as to reduce the drag effect or adherence due to liquid surface tension of float 202 on side-wall 204, there are formed a plurality of projections referenced 206 protruding generally radially

from float 202, as seen in cross-sectional view 3-3. Similarly, in Figure 16, so as to reduce the drag effect of float 222 on side-wall 224, there are formed a plurality of projections referenced 226 protruding generally radially from float 222, as seen in cross-sectional view 4-4. It will be appreciated by persons skilled in the art, that Figures 15 and 16 represent examples of projections and that the type and number of such protrusions is not limited by the examples disclosed hereinabove.

Referring now to Figure 17 in accordance with an added embodiment of the present invention, there is seen schematic view of a liquid flow rate monitoring apparatus generally referenced 230 having a spherical float 232, which has advantages of reduced drag against side-wall 234, greater stability, and which also serves as a closure against reverse flow at inlet recess 236 when there is no liquid flow and as a closure against outlet recess 238 when the liquid flow rate becomes excessive.

In accordance with a further preferred embodiment of the present invention and referring now to Figure 18, there is seen a schematic view of an intravenous apparatus, referenced generally 240. Apparatus 240 includes flexible tubing 246 interconnecting one or more supply bags 242 of medicament, saline solution or nutrients, supported in a position generally higher than the patient to facilitate flow by gravity from bag 242 to the patient. Operatively connected to each bag 242 requiring a controlled flow rate therefrom is a liquid flow monitoring apparatus referenced 244 of the invention in liquid flow association with valve 248, and connected to an intravenous needle/cannula unit referenced 250 for

introducing medicament, saline solution or nutrients into a vein (not shown) of a patient.

This preferred embodiment is particularly useful in infusion sets. For example, in events wherein numerous injured subjects are involved (e.g., car accidents, terror attacks), infusions are often provided by one or more paramedics to substantially large number of subjects and it is thus almost impossible for the paramedics to regulate the flow rate of conventional infusion sets without loosing precious time for treating injuries. Advantageously, the flow rate of infusion sets utilizing the monitoring apparatus of the invention can be rapidly regulated since the flow rate can be instantly read by following the float displacements.

Conventional infusion sets comprise a filter located at the lower part of the drop-counting chamber. This configuration is problematic since air bubbles are sometimes trapped in the filter and then later released, following which they may be trapped in the apparatus at the lower part of the float, during the operation of said apparatus. As a result the float buoyancy is changed and the accuracy of flow rate readings is spoiled.

Figs. 19A, 19B, and 19C, show a cross-sectional view of the monitoring apparatus of the invention wherein a filter chamber is provided at the lower part (18) of the apparatus. In the preferred embodiment shown in Fig. 19A the filter chamber 27a is provided at the lower end 18 of the monitoring apparatus 19a. A filter 1 is disposed in chamber 27a which is in fluid communication with the apparatus interior via conical-shaped recess 26. Fig. 1D shows a top view of the filter 1.

An improved filter chamber 27b is shown in Fig. 19B, wherein the air bubbles are trapped in an annular booth 2

defined at the upper part of filter chamber 27b. The annular booth 2 is preferably defined by an annular protrusion 3 extending downwardly from, and axially centered with, conical-shaped recess 26.

According to yet another preferred embodiment of the invention, shown in Fig. 19C, only a portion of the filter 1 is actually used in order to prevent appearance of interfering air bubbles on filter 1. In this preferred embodiment the filter chamber 27c is partitioned by an annular protrusion 3 extending downwardly from, and axially centered with, conical-shaped recesses 26, and by a corresponding annular protrusion 4 extending upwardly from, and axially centered with, liquid outlet 22. In this way the annular protrusions 3 and 4 defines a fluid passage via filter chamber 27c, which connects conical-shaped recesses 26 and liquid outlet 22, wherein fluids flowing therethrough pass via a portion of filter 1.

Another way to prevent the occurrence of interfering air bubbles in the monitoring apparatus of the invention is shown in Fig. 20, wherein a filter chamber 23 is provided at the upper end 16 of the monitoring apparatus 25. In this preferred embodiment there is no need to partition the filter chamber 23 since air bubbles that may be trapped in the filter 1 and released during operation will not interfere with the float indications. Instead, such air bubbles will leave the apparatus via outlet 20.

It is of course possible to provide filter 1 at other locations along the fluid flow path separated from the flow monitoring apparatus (e.g., embedded with the flow regulating valve - 248 in fig. 18).

In accordance with an embodiment of the present invention, there is a method for monitoring a liquid flow

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rate through an intravenous therapy apparatus, including the steps of:

- a) providing a liquid flow monitoring apparatus, including flow rate indicator means having a flow rate indicator float, in liquid flow association with an intravenous therapy apparatus;
- b) purging air from the liquid flow monitoring apparatus by causing liquid to flow from a liquid supply member into a liquid inlet of the intravenous therapy apparatus and therethrough;
- c) preselecting a rate of flow of liquid through the intravenous therapy apparatus;
- d) providing a visual indication of the rate of liquid flow through the liquid flow monitoring apparatus as indicated on the flow rate indicator means, by linear displacement of the flow rate indicator float;
- e) selectively adjusting the rate of liquid flow through the intravenous therapy apparatus;
- f) visually inspecting the position of the flow rate indicator float against the flow rate indicator means; and
- g) associating the position of the flow rate indicator float in the flow rate indicator means with the rate of liquid flow through the intravenous therapy apparatus.

The method, according to an embodiment of the present invention, further includes, following step b), the step of repeating the purging of air from the flow monitoring apparatus.

It will be appreciated by persons skilled in the art that the present invention is not limited by the drawings and description hereinabove presented. Rather, the invention is defined solely by the claims that follow.